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GETTING ON TRACK TO NET ZERO
TEN MILLION HEAT PUMPS FOR HOMES BY 2030

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Summary

Heat decarbonisation is one of the main credibility gaps in the UK's net zero ambition. Six times more customers are being connected to the gas grid each year than took up low carbon heating in 2019. There is a 'need for speed' to get on track for net zero:

1. The Government needs to deliver existing policy commitments and manifesto funding pledges relating to energy efficiency in stimulus plans, the Infrastructure Strategy and Spending Review, link this to heat decarbonisation, and deploy a further £0.5 billion per year to 2030 to drive the take-up of energy efficiency improvements by able to pay households.

2. The two-year £100 million Clean Heat Grant for heat pumps announced at Budget, slated to commence in April 2022, needs to be brought forward to today as a stimulus measure, deployed as a 'fossil-for-clean' heating system scrappage scheme, conditional on basic energy efficiency measures, and offered to consumers as an alternative to the Renewable Heat Incentive.

3. The Government's Heat and Buildings Strategy, expected later this year, needs to set a medium-term goal to reduce today's heat-related emissions by 50% by 2030, with a commensurate policy framework spanning governance, learning, innovation, skills and regulation, accompanied by a financing plan.

4. The delayed Spending Review needs to fund successors to the Heat Networks Investment Project, the RHI and a brought-forward Clean Heat Grant, at a level that enables the UK to meet the 2030 goal – in our estimation £2.3 billion investment additional to today's level of support – deployed primarily to reduce the up-front capital costs of heat pumps households face, and bringing it into line with peers such as Austria, France and the Netherlands.

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Context

The decarbonisation of heat – especially in buildings – is perhaps the major gap in, and a major challenge for, how the UK is to meet its net zero target. Heating our buildings – space heating and hot water – accounts for 21% of the UK's greenhouse gas emissions[1], second only to transport. Currently, 8% of the UK's heat is provided from renewable energy.

Climate science is clear that significant decarbonisation progress must be made in the next 10 years to get on track to limit the global average temperature to 1.5C – globally cutting carbon emissions by 45% between now and 2030[2] – which demands decisiveness and speed. There are only two heating system replacement cycles between now and 2050[3]. A decision on substantive new action to decarbonise heat to 2030 is needed this year for the UK to get on track.

There are numerous technological options for decarbonising heat, all of which will have a role to play at different times and geographies. The further development of heat networks is currently being actively pursued in dense urban areas, mainly in new developments, and is supported by the Heat Networks Investment Project (HNIP)[4], effectively coordinated by the Heat Networks Delivery Unit. The Renewable Heat Incentive (RHI) has supported the deployment of heat pumps, biomass boilers and solar thermal systems mostly in commercial buildings and rural, off-gas homes[5] – albeit in numbers and orders of magnitude below what is needed – as well as the injection of biomethane, mostly from anaerobic digestion, into the gas grid. The RHI recorded approximately 11,000 installations in 2019, contrasting sharply with 60,000 customers connected to the gas grid each year[6].

The Government announced in Budget 2020 its intention to extend the RHI for one year to March 2022. It is will consult on three new policies to sustain support for heat decarbonisation thereafter: a £100 million grant scheme over two years to support heat pump and biomass boiler deployment, a £270 million Green Heat Networks Scheme and a Green Gas Levy to support biomethane injection into the gas grid.

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[1] BEIS (2018) ***Clean Growth – Transforming Heating: Overview of Current Evidence***

[2] IPCC (2018) ***Global warming of 1.5°C***

[3] Assuming people replace their heating system approximately every 15 years.

[4] BEIS (2018) ***Heat Networks Investment Project (HNIP): introduction to the scheme***

[5] BEIS (2020) ***RHI monthly deployment data: December 2019 (Annual edition)***

[6] ENA (2015) ***Guide to the UK and Ireland energy networks***

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The Future Homes Standard is expected to rule out fossil heating in new homes from 2025 at the latest. There are trials underway testing various aspects of using hydrogen for heat via the gas network[7], heat pumps rollout[8], hybrid heat pump systems and controls[9], and new business models for providing low carbon heat[10].

Each technology comes with its own opportunities and challenges. The foremost challenge they all share is that supportive policies and deployment are far from commensurate with the scale and pace of decarbonisation needed. Another shared theme is the enormous role energy efficiency improvements need to play to reduce heat loss and the cost of keeping warm[11]. Heat decarbonisation therefore goes hand in glove with the Glasgow Action Plan's priority to make all homes highly energy efficient by 2030[12].

Prior to the coronavirus pandemic, the UK Government's Heat and Buildings Strategy had been expected later this year, as were the Spending Review and Infrastructure Strategy, which will decide on the broader heat decarbonisation approach beyond and in addition to the announcements made at Budget. These decision points do not need to get everything right for 2050, but they must put the UK on the right path, including in response to the current economic crisis. The key consideration as we look to 2030 is **speed** in securing economic benefit and reducing emissions, compatible with getting on track to net zero.

The need for speed

Deployment of 10 million heat pumps by 2030, alongside energy efficiency improvements, can drive rapid reductions in CO_2 emissions from heat. Illustrative scenarios developed for the National Infrastructure Commission (NIC)[13] show how, compared to business as usual[14] (BAU), heat pumps deployed at this scale

[7] E.g. Hy4Heat; see **www.hy4heat.info**

[8] BEIS (2019) ***Electrification of Heat Demonstration Project***

[9] **Freedom Project: Final Report**

[10] ESC (2019) ***Bristol Energy becomes first UK supplier to trial "heat as a service"***

[11] Without energy efficiency, the costs of decarbonising heat have been estimated to be £6.2 billion higher per year to 2050. See Imperial College London for the CCC (2018) ***Analysis of Alternative UK Heat Decarbonisation Pathways***

[12] TCC (2020) ***Glasgow Action Plan***

[13] Element Energy & E4tech for NIC (2018) ***Cost analysis of future heat infrastructure options***

[14] Incremental improvements in energy efficiency and more efficient boilers.

could cut cumulative heat-related emissions from buildings to 2030 by 25%, with in-year emissions in 2030 44% lower than under BAU – broadly in line with what climate science requires.

The illustrative scenario for hydrogen at scale – 'blue' hydrogen, produced using natural gas with steam methane reforming (SMR) plus carbon capture and storage (CCS) – takes longer to get off the ground[15]. Cumulative emissions to 2030 would be 11% lower, with in-year emissions cut by 17%[16].

This difference in speed of mitigation is principally down to the anticipated lead time convert the gas grid and to produce low carbon 'blue hydrogen' at scale, which relies on a total 1,040 $MtCO_2$ carbon capture and storage (CCS) capacity between now and 2050, or an average annual capture capacity to be created of 35 $MtCO_2$ for 30 years. Current plans for CCS cover[17]:

> Teesside: up to 6 $MtCO_2$ per year from 2030 – albeit attached to a gas-fired power plant.

> Humber: over 10 $MtCO_2$ per year, at full scale from 2040 – albeit designed for bio-energy with CCS (BECCS) attached to Drax power station.

> Acorn: 152 $MtCO_2$ total capture capacity at 5 $MtCO_2$ per year, with injection planned to start in 2023 at 0.1 to 2 $MtCO_2$ per year[18] – situated near a major gas terminal and therefore could be combined with SMR. And adjacent to Acorn, at an earlier stage of development:

> East Mey: 500 $MtCO_2$ cumulative at 5$MtCO_2$ per year; could start within the 2020s at 0.1 to 2 $MtCO_2$ per year – and could also be combined with SMR to produce hydrogen.

Under known plans, by 2030 no more than 7 $MtCO_2$ annual CCS capacity is likely to be available to SMR for blue hydrogen production. Moreover, there are numerous higher value and harder to decarbonise applications than heating buildings, for which the use of at-scale low carbon hydrogen – especially 'green' hydrogen produced through electrolysis powered by renewables – has priority in

[15] 'Green' hydrogen is produced using electrolysis with renewable power, an energy carrier needed to fully decarbonise the economy and may have a role to play in decarbonising heat for buildings. However, it not considered viable at this scale, primarily owing to the better value applications the additional renewable power that would be required could be used for (such as electric heat), as well as the other applications for it that would take precedence (industry, freight).

[16]

[17] Global CCS Institute (2019) ***Global Status of CCS 2019: Targeting Climate Change***

[18] ACT Acorn (2019) ***Unlocking underground CO_2 storage***

a net zero economy. These include heat-driven industrial processes (14% of the UK's greenhouse gas emissions[19]), rail, heavy goods vehicles and potentially shipping.

While incompatible with the need for speed, the role hydrogen has in decarbonising heat could therefore be expected to come into play in the 2030s, potentially as part of a balanced approach overall from then to 2050[20].

Net zero compatibility

The NIC's illustrative scenario of blue hydrogen for heating buildings sees heat-related emissions reduced by 80% in 2050. Constraints on mitigation potential stem from the limits to deployment (on-gas buildings), the capture rate of CCS, assumed at 90%, and the significantly larger volume – 47% more than is currently used for heating – of natural gas and imports that would need to be secured for blue hydrogen production[21] to deliver the same amount of useful heat. Not counted in the scenario are the emissions from human-caused fugitive fossil methane emissions in the extraction and production of fossil fuels – more of which would be required.

In 2018, the CCC assessed the lifecycle emissions – factoring in fugitive methane – of blue hydrogen combustion, finding that it could achieve emissions reductions of between 60-85% compared to natural gas[22]. The CCC concluded that if blue hydrogen were deployed in very large quantities, this saving may be "insufficient to meet stretching long-term emissions targets", which have since been revised from an 80% cut by 2050 to the net zero target adopted last year. In addition, fugitive fossil methane emissions have recently been estimated to be 25-40% higher than previously thought[23]. At-scale production of blue hydrogen for heating buildings is therefore all but irreconcilable with achieving net zero emissions in 2050.

Green hydrogen will have a critical role to play in hard-to-decarbonise sectors such as high-temperature industrial processes, rail and road freight. Its economic

[19] BEIS (2018) ***Clean Growth – Transforming Heating: Overview of Current Evidence***

[20] See, for example Navigant for ENA (2019) ***Pathways to Net-Zero: Decarbonising the Gas Networks in Great Britain***

[21] Ibid.

[22] CCC (2018) ***Hydrogen in a low-carbon economy***

[23] Carbon Brief (2020) ***Methane emissions from fossil fuels 'severely underestimated'***

potential is likely to be exhausted before those needs are met however[24], meaning it is highly unlikely to contribute to heating buildings to any significant degree – not least because the electricity generated could be put to far more efficient (and cheaper) use by heating buildings directly[25]. This is also the conclusion of very recent research commissioned by Germany's Economy Ministry to inform its hydrogen strategy, wherein hydrogen is not recommended to be deployed for heating buildings and driving cars[26].

Net zero is also challenging for electrified heating. The NIC's illustrative scenario for heat pumps sees emissions 90% lower in 2050, with the residual emissions in their scenario arising from the assumed remaining carbon intensity of electricity generated to power them[27]. However, it is possible to reduce electricity emissions to zero, heat pumps already achieve emissions reduction compared to gas boilers[28], and there would be no associated and uncounted fugitive CO_2 or methane emissions associated with the supply of gases for heat in buildings.

Deployment and learning

Heat pumps are a tried and tested technology and enjoy mature across Scandinavia, Finland, Estonia, Switzerland, Austria, France and Italy[29]. The UK does not currently have a significant market for heat pumps – 10,000 were deployed in homes last year, well short of expectations for the Renewable Heat Incentive, leaving the UK far behind its European neighbours for renewable heat, as shown in Figure 1.

[24] The CCC estimates that up to **44 TWh of green hydrogen per year in 2050** could be produced in the UK using surplus renewable power. In 2018, **77 TWh of natural gas was used for industrial process heat** alone.

[25] The CCC estimates that the system efficiency (from power generation to useful heat) of using green hydrogen for heat is 62%, compared to between 230-410% for heat pumps.

[26] Prognos for BMWi (2020) ***Kosten und Transformationspfade für strombasierte Energieträger***

[27] The NIC's scenarios pre-dated the UK's net zero target, but did aim to maximise emissions reductions from heating buildings.

[28] Owing to the lower carbon intensity per kWh of power compared to gas, coupled with fewer kWhs needed.

[29] Ecuity (2020) ***Comparative analysis of Clean Heat Grant Scheme***

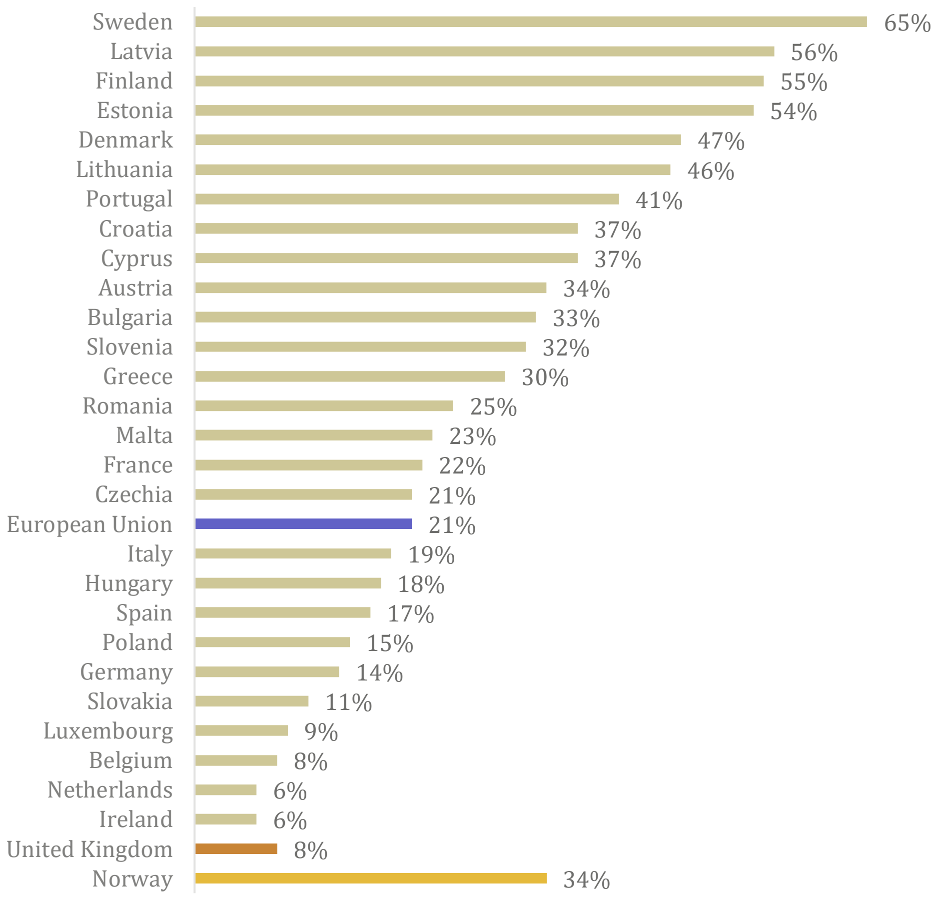

*Figure 1: % of gross final energy consumption for heating and cooling, 2018 [**eurostat 2020**]*

Deploying 10 million heat pumps to 2030, while consistent with climate science and the need for UK leadership, is undoubtedly a major challenge. The lowest regret pathway to deploying heat pumps to 2030 at this scale must begin with:

> *Energy efficiency*: making all UK homes highly energy efficient by 2030[30], reducing the cost to households of decarbonised heat and rapidly increasing the pool of properties suitable for heat pumps to achieve optimal performance.

> *New build*: ensuring new homes are net zero compatible should start right away. From 2025 at the latest, ideally sooner, the Future Homes Standard will rule out fossil heating in new homes. The size of the opportunity for deploying low carbon heat in new homes – through heat networks and heat pumps – will amount to between 1.6 and 3 million dwellings to 2030.

[30] As outlined in the context of Covid-19 and economic recovery by EEIG (2020) ***Rebuilding for Resilience***.

> *Off-gas properties*: there are approximately four million homes in the UK in this category, which have been the mainstay of domestic RHI deployment to date. Over half of these could be currently suitable for heat pump deployment[31], more so in conjunction with the manifesto-pledged Home Upgrade Grants for energy efficiency improvements for low income households living in very inefficient homes[32].

> *On-gas, post-war, suburban houses*: typically reasonably efficient, these homes could also be a priority for heat pump deployment, potentially also as hybrid heat pump systems to begin with – combining with a gas boiler to meet peak heat demand using low carbon gas in future, leaving the heat pump to provide over 80% of the heat in this type of home[33]. In England, there are 11 million homes in this category.

Consumer research for the Committee on Climate Change highlights the importance of a national awareness campaign on heat decarbonisation. It found that, when informed and required to make a binary choice, 63% of consumers would opt for a heat pump and 37% for a hydrogen boiler. This may prove useful in reconciling the need for speed in heat decarbonisation with consumer preferences. Raising national awareness of heat decarbonisation, including energy efficiency, as a critical factor on the path to net zero will be essential for households and the supply chain to shift these preferences towards a natural choice. This needs to be informed by comprehensive understanding by both government and commercial actors, of financial and non-financial barriers face – an approach that is underpinning the Green Finance Institute's drive to develop new financial products and services to scale up energy efficiency retrofit[34].

Alongside this, investment in advice, skills and innovation for energy efficiency and the installation, commissioning and maintenance of heat pump and hybrid heat pump systems is paramount. The installer base alone needs to grow to 38,000 to deliver 10 million heat pumps by 2030[35], a major employment boost – and for workers furloughed or laid off an opportunity to reskill to the highest standards to assure system performance – in the context of post-pandemic economic recovery.

[31] CCC (2018) ***Cleaning up the UK's heating systems: new insights on low-carbon heat***

[32] Conservatives (2019) ***Our manifesto gets Brexit done and unleashes the potential of the whole country***

[33] Element Energy for BEIS (2017) ***Hybrid Heat Pumps***

[34] See GFI (2020) ***Financing energy efficient buildings: the path to retrofit at scale***

[35] Estimate based on HPA (2019) ***Delivering Net Zero: A Roadmap for the Role of Heat Pumps***

In the first instance, consumer demand will need to be pump-primed using alternative incentives to the RHI. To unlock finance and give the supply chain further confidence to invest, this should be supported by a review of structural incentives (such as measures that affect the relative price of natural gas and electricity), the leveraging of energy efficiency programmes (such as Home Upgrade Grants and the Social Housing Decarbonisation Fund), be underpinned by regulation – such as an emissions performance standard for home heating renewal, coupled with 'backstop' regulation that stops new gas network connections and fossil heating being installed – and reward, such as for smart and responsive heat demand. The latter needs to be underpinned by regulatory reform of the energy market that supports new business models – already emerging – that capture new value streams arising from flexible demand services that triangulate smart EV charging, storage, connected appliances and small-scale solar with electric space and hot water heating demand.

Supply chain development could be further boosted by a heat pumps sector deal – analogous to that for the offshore wind industry – for example anchored to a heat pump manufacturing plant located in Livingston, Scotland, that is already being explored[36]. Kensa, a British firm, manufactures ground source heat pump systems in Cornwall. A sector deal can be designed to support UK criteria for economic stimulus in response the economic crisis induced by the coronavirus pandemic that builds on the insights of other sector deals, BEIS' current heat electrification demonstration project, and lessons from Scotland and the Netherlands on the development of local government leadership to plan for heat decarbonisation. In both the Scottish and Dutch cases, local heat planning is across the residential, commercial and public sectors, integrated with energy efficiency and supported by national government investment and resources.

Immediate next steps

Heat pumps meet the International Energy Agency's lessons and criteria[37] for a net-zero stimulus package in response to the pandemic-induced economic crisis in the near-term, with the potential to deliver:

> A swift boost to jobs and SMEs across the country compatible with long-term goals;

> Scale-up of ready, future-proof technology and supply chains;

[36] Climate Emergency Response Group (2019) ***12 immediate actions for Scotland's response to the Climate Emergency***

[37] IEA (2020) ***What the 2008 financial crisis can teach us about designing stimulus packages today***

> Low risk, as millions of homes constitute a diversified project portfolio;

> Support for industrial strategy objectives through a sector deal;

> Long-term resilience, through reduced energy costs and imports.

The need for speed is therefore now urgent across economic and environmental dimensions. To fulfil it, get on track to net zero, and for the UK to have a credible plan, demonstrating its leadership towards next year's COP26 and beyond:

1. The Government needs to deliver existing policy commitments and manifesto funding pledges relating to energy efficiency in stimulus plans, the Infrastructure Strategy and Spending Review, establish links to heat decarbonisation where possible, and deploy a further £0.5 billion per year to 2030 to drive the take-up of energy efficiency improvements by able to pay households[38].

2. The two-year £100 million Clean Heat Grant scheme for heat pumps announced at Budget and currently out for consultation, slated to commence in April 2022 needs to be brought forward to today as a stimulus measure, deployed as a 'fossil-for-clean' heating system scrappage scheme, conditional on installing basic energy efficiency measures (as under the RHI), and offered to consumers as a RHI alternative. This could double the market for heat pumps in the near-term, albeit from a low base.

3. The Government's Heat and Buildings Strategy, expected later this year, needs to set a medium-term goal to reduce today's heat-related emissions by 50% by 2030, with a commensurate policy framework spanning governance, learning, innovation, skills and regulation as outlined above, accompanied by a financing plan.

4. The Government's Spending Review, expected to cover the next two to three years, needs to fund successors to HNIP, the RHI and a brought-forward Clean Heat Grant, at a level that enables the UK to meet the 2030 goal – in our estimation £2.3 billion investment additional to today's level of support for heat decarbonisation, deployed primarily to reduce the up-front capital costs of heat pumps households face, and bringing it into line with peers such as Austria, France and the Netherlands.

[38] See EEIG (2020) ***Rebuilding for Resilience***.